Southwest Fisheries Science Center
Administrative Report H-98-01

MARO REEF JUVENILE SPINY LOBSTER SURVEY, 1993-97

Wayne R. Haight

Joint Institute for Marine and Atmospheric Research
University of Hawaii at Manoa, Honolulu, Hawaii 96822
Mailing address: National Marine Fisheries Service, 2750 Dole Street,
Honolulu, Hawaii 96822-2396

This Administrative Report is issued as an informal document to ensure prompt dissemination of preliminary results, interim reports, and special studies. We recommend that it not be abstracted or cited.

INTRODUCTION

In 1990, a significant reduction in research and commercial catch-per-unit-effort (CPUE) for all age groups of Hawaiian spiny lobster (*Panulirus marginatus*) was observed at Maro Reef in the Northwestern Hawaiian Islands (NWHI). Annual assessment cruises from 1991 to 1997 indicated that low CPUE of all age groups continued through 1997. This trend persists despite significant reductions in commercial fishing effort at Maro Reef from 1991 through 1995.

The decline in spiny lobster abundance prompted the National Marine Fisheries Service Honolulu Laboratory (NMFS-HL) to begin exploratory trapping in the shallow reef areas of Maro Reef to survey juvenile spiny lobster habitat and abundance to determine if juvenile spiny lobster (less than 50 mm tail width) abundance could be used as an index of recruitment to Maro Reef and provide a way to forecast recruitment to the Maro Reef commercial fishery. This report summarizes the results of the exploratory surveys conducted from 1993 to 1997.

METHODS

Exploratory trapping for juvenile spiny lobster was conducted annually during the NMFS-HL summer lobster assessment cruise from 1993 through 1997. Four sites (1, 2, 3, 4) (Fig 1.) encompassing the span of the reef were trapped in depths of 1-15 m. From 1994 through 1996 additional trapping was conducted at site 1 to survey the spatial distribution of juvenile lobster at this area of Maro Reef. At each of the four sites bottom habitat type was surveyed *in situ* using diver-operated video cameras.

All trapping operations near the reef were conducted from small boats (~5 m) with traps set and hauled manually. This type of operation limited trapping effort to 20–30 trap hauls per day. All sites were surveyed using black plastic Fathom Plus traps buoyed individually and set in lines of 12 to 15 traps, spaced at 100-150-m intervals (trapline). Each trapline was approximately 2 km long. All traps used were unvented (no escape vents), baited with 0.75 kg of previously frozen mackerel, and left to soak overnight. Upon retrieval of the traps, all lobster present in the traps were identified by species and sex, carapace length (CL) and tail width (TW) were measured, and reproductive condition was noted. Mean length of spiny lobster was compared between sites by year and between years by site using the Ryan-Einot-Gabriel-Welsch (REGWF) multiple F test (SAS, 1990). Mean CPUE of juvenile lobster at site 1 was compared between years using GLM analysis (SAS, 1990).

Since the survey design was limited by the number of traps that could be hauled each day, it was crucial to determine the survey duration (years) required to detect significant changes in CPUE. The number of years the juvenile survey must be continued to detect a significant trend in juvenile CPUE was computed using the following formula:

$$r^2 n^3 \geq 12CV^2 (Z_{\alpha/2} + Z_\beta)^2, \tag{1}$$

where r = the rate of change in the population size, n = number of survey years, CV = the coefficient of variation in site 1 juvenile survey CPUE, Z_α = the percentile of a standardized normal curve for a one-tailed Type I error, and Z_β = the percentile of a standardized normal curve for a one-tailed Type II error (Gerrodette, 1987). The formula was solved using an iterative minimization routine.

The hypothesis that the survey sample size (number of traps hauled per year) was sufficient to detect interannual differences in juvenile CPUE at site 1 was tested using the following formula:

$$n \geq 2(\sigma/\delta)^2 \{t_{\alpha[v]} + t_{2(1-P)[v]}\}^2, \tag{2}$$

where n = the number of traps needed, σ = standard deviation, δ = the smallest difference desired to detect, ν = the degrees of freedom of the sample standard deviation , α = significance level, P = desired probability that a difference will be found significant, and $t_{\alpha[v]}$ and $t_{2(1-P)[v]}$ = values of the two-tailed t-table with ν degrees of freedom corresponding to probabilities of α and 2(1-P), respectively (Sokal and Rolf, 1969). The formula was solved using an iterative minimization routine.

RESULTS

Of the four sites surveyed, the smallest spiny lobster were caught at site 1. The mean size of spiny lobster was significantly smaller at site 1 than at the other three sites (2,3,4) inside the reef (Prob>F = 0.001, DF = 5) (Table 1).

Table 1.--Mean tail width (mm) of spiny lobster at the Maro Reef shallow sites by year.

Year	Site			
	1	2	3	4
1993	35.58	57.20	53.13	55.10
1994	33.56	54.18	52.53	54.58
1995	33.50	54.86	55.00	-
1996	34.67	54.61	56.83	54.00
1997	33.07	-	-	-

Mean size of spiny lobster from the three sites inside the reef indicated that the majority of lobster at these sites were above adult size. However, at site 1 at the northwestern spur of Maro reef, size frequency distributions indicated highest catch rates for juvenile lobster (<50mm TW) (Fig. 2). There were no significant between-year changes in mean size of lobster at any of the sites. (Prob>F = 0.89, DF = 3). Although CPUE of the juvenile lobster appeared to vary between years, the results of the GLM analysis indicated that mean juvenile CPUE at site 1 was not significantly different between years (Prob>F = 0.24, DF = 59) (Fig. 3).

The CV of the site 1 juvenile survey CPUE series (CV = 1.97, $\alpha = 0.05$, $\beta = 0.05$) was used in formula (1) to determine the number of years the current survey design must be continued to detect a 50% change per year in relative juvenile spiny lobster abundance. This resulted in an estimate of 13.43 years. The variance estimate ($\sigma^2 = 4.67$, $\alpha = 0.10$, P = 0.90) from the juvenile site 1 CPUE analysis was used in formula (2) to calculate the number of trap hauls that would be required each year at this site to detect a 50% difference in mean juvenile CPUE between years. The analysis indicated that at site 1 approximately 150 trap-hauls would be required each year.

Benthic habitat varied considerably between sites. Habitat at the northwestern site was dominated by live colonies of *Pocillopora* and *Acropora* corals. Habitat morphology at this site consisted of reef spur tongue and groove structure indicative of a high energy surge environment. In contrast to the habitat at the northwestern site, habitat at sites within Maro Reef consisted of isolated coral heads composed of individual colonies of *Pocillopora*, interspersed with coral rubble, coralline algae, and sand. Individual coral reef structures inside the reef were separated by large sand plains. No *Acropora* colonies were found at sites within the reef.

DISCUSSION

Exploratory trapping indicates that a concentration of juvenile spiny lobster occurs at the northwestern portion of Maro Reef. This arm of the reef extends outward from the lagoon area into waters exposed to strong currents and wave action, and includes habitat that is unique among the sites surveyed. Of note is the presence of *Acropora* sp. colonies at site 1. These corals were not present at any of the sites inside the reef and are rare in waters outside the reef (F. Parrish, unpub. data). In Hawaii, *Acropora* sp. are found only from Kauai to Laysan Island, and their recruitment seems to be correlated with the subtropical countercurrent (Grigg, 1981). The subtropical counter current is a system that is directly affected by the strength of mesoscale geostrophic flow in the NWHI and has been identified as a potential transport mechanism for larval spiny lobster in the archipelago (Polovina and Mitchum, 1992).

Although possible mechanisms underlying fluctuations in juvenile spiny lobster recruitment to Maro Reef have been identified, currently there is no viable index of recruitment for these lobsters at Maro Reef. The discovery of an aggregation of juveniles at the northwestern tip of the reef was the first step in developing a recruitment index for Maro Reef. If significant changes in abundance of juveniles could be detected and correlated with changes in oceanographic indicators and adult catch rates in the commercial fishery, this correlation could be used to develop a recruitment forecasting tool.

The development of a forecasting tool requires that the sample design be robust enough to detect interannual changes in relative abundance, or at least detect significant population trends within a realistic time frame. The estimated required sampling duration of 13 years to detect a 50% per year change in juvenile CPUE under the present design is untenable from a management perspective. Increasing the sample design to the 150 traps per survey needed to detect interannual differences in CPUE of 50% is also impractical given the constraints of trap survey operations from small boats. Unfortunately, small boats are the only viable platform to conduct trap surveys in the shallow waters of Maro Reef. Therefore, it is recommended that the small boat juvenile CPUE survey at Maro Reef be discontinued.

CITATIONS

Gerrodette, T.
1987. A power analysis for detecting trends. Ecol. 68(5):1364-1372.

Grigg, R. W.
1981. *Acropora* in Hawaii. Part 2. Zoogeography. Pac. Sci. 35(1):15-24

Polovina, J. J., and G. T. Mitchum.
1992. Variability in spiny lobster, *Panulirus marginatus* recruitment and sea level in the Northwestern Hawaiian Islands. Fish. Bull., U.S. 90:483-493.

SAS Institute Inc.
1990. SAS/STAT Users Guide, Version 6, Fourth edition, Volume 2. SAS Institute, Cary, N.C. U.S.A.

Sokal, R. S., and F. J. Rolf.
1969. Biometry. The principles and practice of statistics in biological research. W.H. Freeman and Company, San Francisco. 776 p.

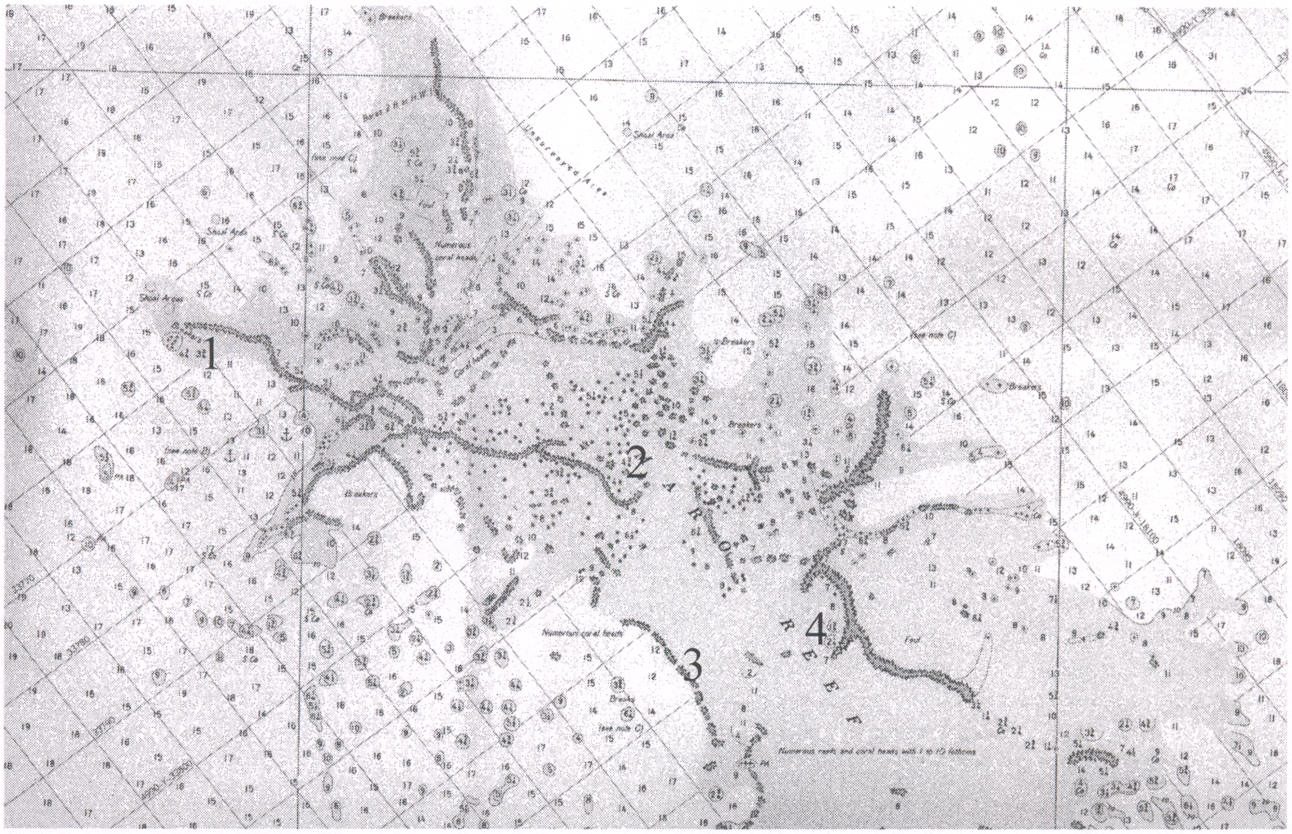

Figure 1. Maro Reef survey sites.

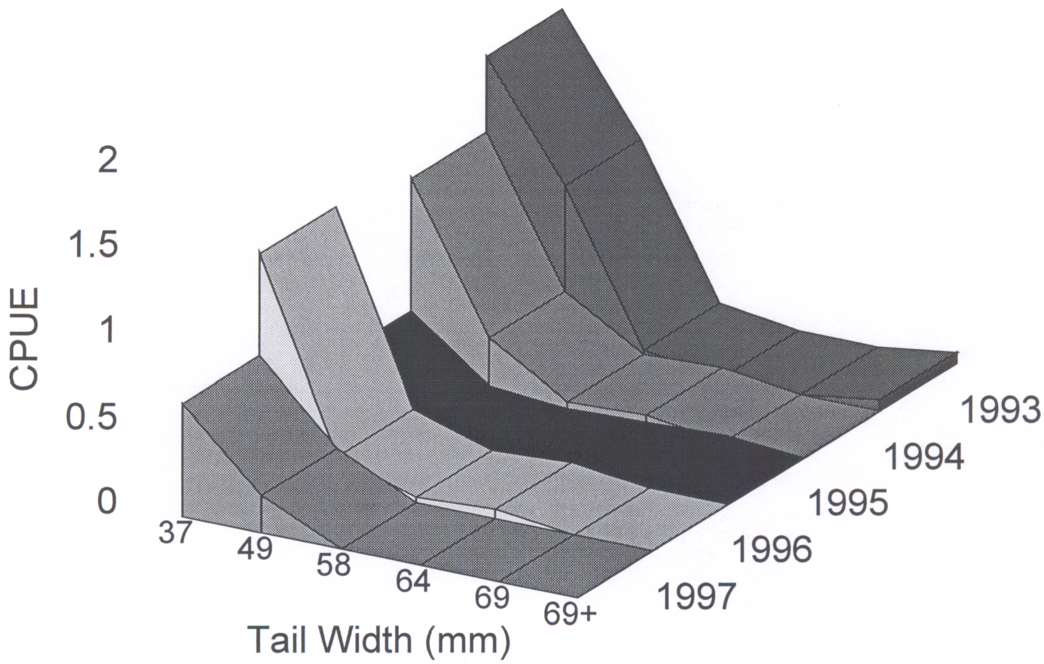

Figure 2. CPUE by size for spiny lobster at site 1, 1993-1997.

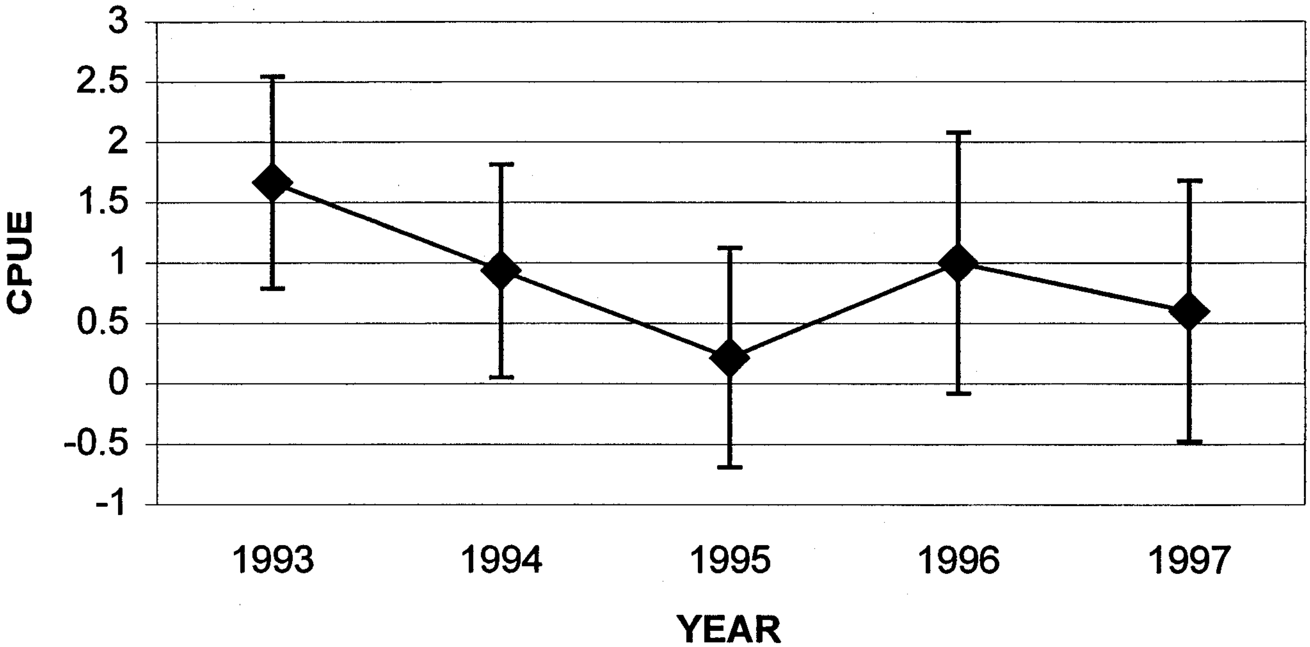

Figure 3. CPUE of juvenile spiny lobster at Maro Reef site 1